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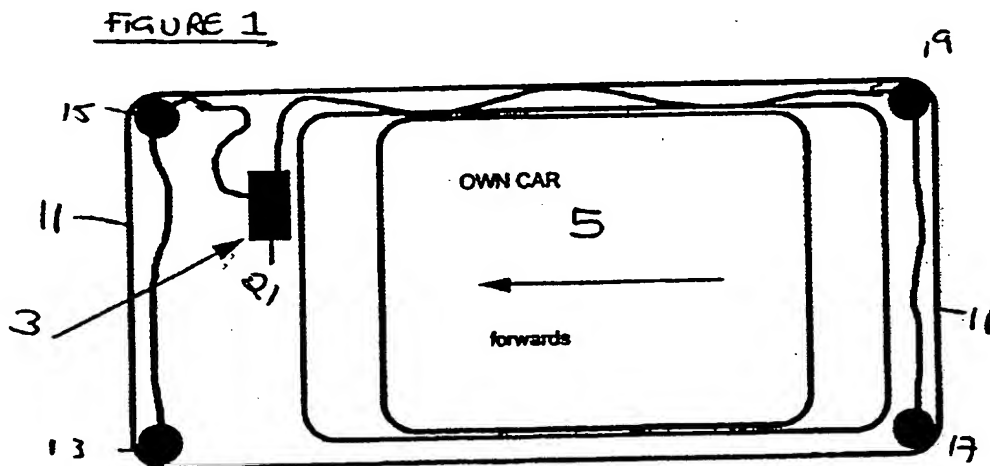
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U1S S1820

(56) Documents Cited  
GB 2287917 A EP 0144837 A2

(58) Field of Search  
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(54) Abstract Title  
Collision avoidance system with sensors mounted on flexible p.c.b.

(57) A sensor assembly for a collision warning system 3 for a motor vehicle 5 comprising four sensor assemblies 13,15,17,19, each consisting of a flexible printed circuit board 7 (Fig.2, not shown) having printed upon it sensor electronics, the arrangement whereby the flexible printed circuit board 7 may be mounted on the inside of the vehicle bumper 11.



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FIGURE 1

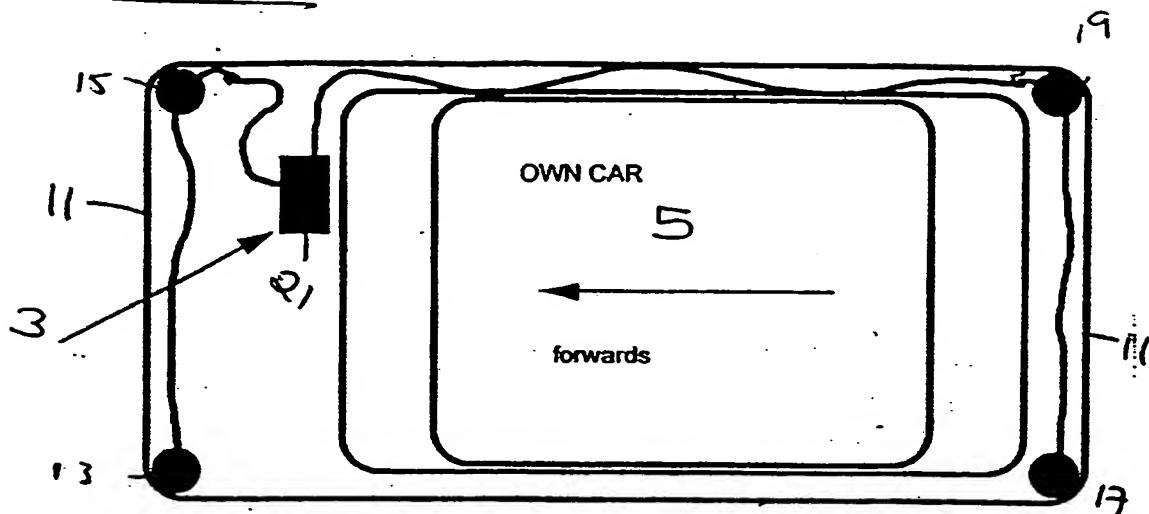
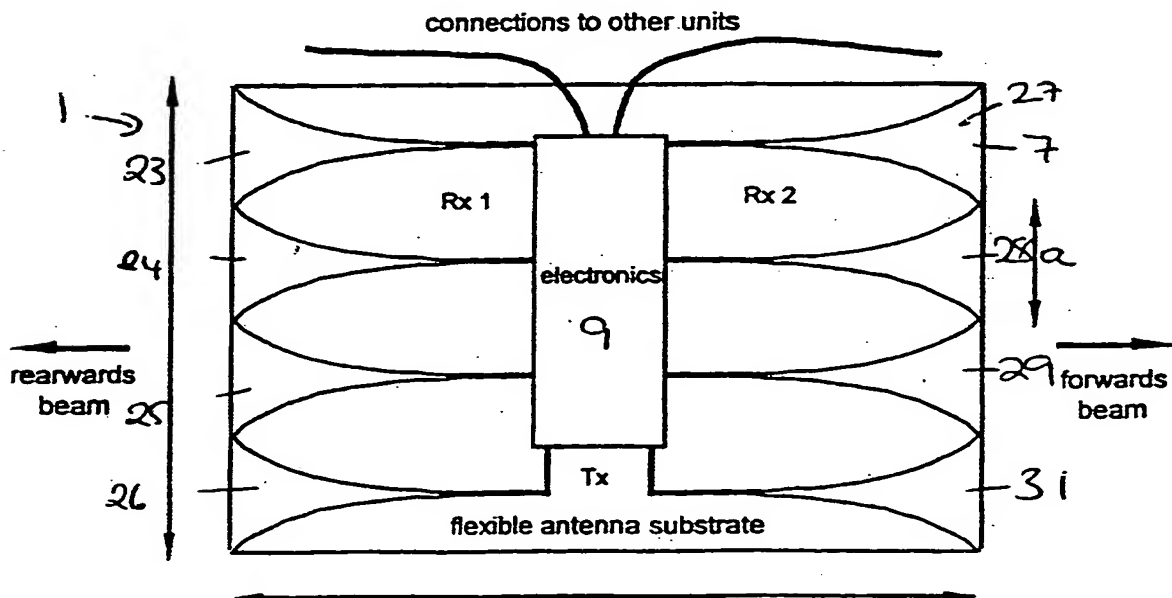


FIGURE 2



**IMPROVEMENTS IN SENSOR ASSEMBLIES FOR AUTOMOTIVE COLLISION  
WARNING SYSTEMS**

Field of the Invention

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The invention relates to an improved sensor assembly for a collision warning system for a motor vehicle.

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Various different types of collision warning systems have been proposed for motor vehicles which will warn of potential collision with moving targets, primarily other vehicles, and stationary obstacles especially when parking. Such systems include 'closing vehicle same lane warning systems' for looking behind a vehicle when it is travelling forwards for noting when a vehicle is approaching from the rear, parking aids for looking forwards when the vehicle is travelling slowly forwards and backwards when the vehicle is travelling slowly backwards, backup aids, short range frontal collision warning systems for looking ahead of the vehicle while driving forwards, parking space measuring aids for measuring the length of a parallel parking space to the side of the vehicle, driver induced impaired visibility aids to help ensure that the driver can notice vehicles approaching his side in an overtaking lane, side vision aids for looking to the side of the vehicle and lane change aids for checking that the driver is free to overtake, or indeed move to an inside lane.

Collision warning systems have been developed for motor vehicles which utilise sensor assemblies including transmit and receive antennas for scanning the area around a vehicle. Many such systems require a view of 360 degrees around the vehicle especially when the system is a multifunctional system capable of operating in a number of modes of collision warning.

Typically sensors are mounted at or about the corner of the vehicle, conveniently in the region of the bumper. However this results in the sensor assembly being mounted in a vulnerable area since even in a low speed impact the bumper is susceptible to damage. In many vehicles the bumper is arranged to conform to absorb such impacts.

The styling of a vehicle can make the choice of position for mounting a sensor assembly difficult. Moreover designs of bumpers vary widely over the front designs of cars and it can be difficult to design a sensor assembly which can be conveniently mounted in this region for all vehicles.

#### Summary of the Invention

According to the invention there is provided a sensor assembly for a collision warning system for a motor vehicle comprising a flexible printed circuit board having printed upon it sensor electronics, the arrangement whereby the flexible printed circuit board may be mounted on the inside of the vehicle bumper.

The advantage of the flexible printed circuit board is that the sensor assembly may be easily packaged within the bumper at any corner of the vehicle without compromise to either bumper or sensor performance and without impact on vehicle styling. Because the sensor assembly is flexible it will have some crash impact survival characteristics. The flexible sensor assembly will be usable on different designs of bumper which will allow the design to be re-used in many vehicles with different bumper and styling line designs.

Preferably the flexible substrate for the circuit board is polyester which is cheap and flexible. However polyamide may be used as the substrate material where high accuracy and stability are required.

Preferably the flexible substrate includes an adhesive layer to allow the sensor to be adhered to the inside of the bumper. This results in better styling in contrast with other invasive sensor assemblies which require holes in the bumper and/or chassis.

Although flexible PCB's are well established and have been used in automotive applications including substrates for the electronics behind dashboards they have not hitherto been proposed for use in collision warning systems.

The sensors of the sensor assembly may be of any type suitable for use in a collision warning system including radar and ultrasonic.

Preferably the sensor assembly comprises an antenna cluster arranged substantially in accordance with the applicant's co-pending application filed on the same date.

Such an antenna cluster comprises a radar transmit antenna and two receive antennas, the transmit antenna mounted between the receive antennas, a first receive antenna facing towards the front of the vehicle and a second receive antenna facing towards the rear of the vehicle. The collision warning system includes means to trigger the operation of the transmit antenna and one or both of the receive antennas.

This antenna arrangement is particularly efficient if the vehicle includes a collision warning system which includes four such antenna clusters, one mounted at each corner of the vehicle.

Preferably the electronics of the sensor assembly are mounted near the centre of the flexible PCB with external connections from the electronics module. For flexibility near the centre preferably the sensor assembly is mounted on

the bumper such that between the parts of the substrate which are adhered to the bumper and the parts which are connected to the more rigid electronics, there is excess flexible material.

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Preferably the antenna cluster comprises a cluster of impulse radar antennas. Impulse radar is a broadband radar frequency which operates by radiating short radio frequency pulses without a carrier wave. The spectrum of the radiated  
10 signal is very broad. By virtue of transmitting only a short pulse, the reflection from a target arrives after a short delay corresponding to the distance from the target. Such signals can then be interpreted to identify obstacles in areas of interest.

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Preferably the sensor assembly includes at least one antenna in the form of a Vivaldi antenna which comprises a tapered slot which may be printed on a flat surface. Here the tapered slot is printed on the flexible substrate.

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The dimensions of the slot depends on the frequency of wave to be transmitted/received by the antenna. However in the case where the band of operation is 5.46 to 7.25 GHz, preferably each slot comprises an aperture of substantially  
25 42.5 millimetres with a length of substantially 110 millimetres. At about the lowest frequency of 5.5 GHz this gives an aperture of 0.8 wavelengths. Preferably the receive antenna comprises a pair of slots side by side which has the effect of narrowing the elevation pattern making the sensor  
30 less sensitive to the ground and less sensitive to bridges.

Distortion of such antenna during installation does not degrade performance provided that the angle of the surface does not change by more than about plus or minus 25° from  
35 the flat over the area of the antenna.

### Brief Description of the Drawings

An example of a sensor assembly in accordance with the invention will now be described with reference to the accompanying drawings in which : -

Figure 1 is a schematic view of the vehicle illustrating the position of the sensor assemblies; and,  
Figure 2 is a schematic view of the expected shape of an antenna cluster for one corner of the vehicle.

### Description of the Preferred Embodiments

A sensor assembly 1 for a collision warning system 3 for a motor vehicle 5 comprising a flexible printed circuit board 7 having printed upon it sensor electronics 9, the arrangement whereby the flexible printed circuit board 7 may be mounted on the inside of the vehicle bumper 11.

The vehicle 5 is illustrated schematically in figure 1, which depicts the position but not the detail of the bumpers 11 and their mountings. The collision warning system includes 4 sensor assemblies 13, 15, 17 and 19 mounted at the corners of the vehicle inside the bumpers 11.

The sensor assemblies are connected to central unit 21 which contains the means to interpret the signals from the assemblies to work out when a collision warning signal should be issued. The choice of such means will be apparent to the skilled addressee of the specification.

Each sensor assembly is as illustrated in figure 2 and comprises a polyamide substrate 7 having printed upon it the electronics 9 forming the sensor arrangement. The substrate is flexible such that the sensor assembly may conform to various different shapes of bumper. The sensor arrangement is adhered to the inner surface of the bumper.

The sensor comprises an antenna cluster comprising an impulse radar transmit antenna Tx between two impulse radar receive antennas Rx1 and Rx2. Rx1 faces towards the rear of the vehicle and Rx2 faces towards the front of the vehicle.

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Each antenna has a band of operation of 5.46GHz to 7.25GHz. The transmit antenna has a dual beam to the front and the rear whilst each receive antenna has a single beam to the front or to the rear.

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Each antenna is in the form of a Vivaldi antenna, comprising tapered slots 23 to 31 printed upon the flexible PCB 7. Each slot has an aperture 'a' of 42.5mm with a length of 110mm.

Each receive antenna comprises two slots side by side. Thus  
15 antenna Rx1 comprises slots 23 and 24, whilst Rx2 comprises slots 27 and 28 facing in the opposite direction to slots 23 and 24. The transmit antenna Tx comprises two pairs of side by side slots facing in opposite directions. First pair 25 and 26 face rearwards and second pair 29 and 31 face  
20 forwards. The effect of using pairs of slots is that the elevation pattern is narrowed making the sensor less sensitive to ground and less sensitive to bridges.

The angle of the surface of the bumper 11 on which the  
25 substrate 7, is to be mounted does not vary by more than about 25° from flat which does not degrade performance of the antenna.



Claims

1. A sensor assembly for a collision warning system for a motor vehicle comprising a flexible printed circuit board having printed upon it sensor electronics, the arrangement whereby the flexible printed circuit board may be mounted on the inside of the vehicle bumper.
2. A sensor assembly according to claim 1, in which the substrate for the printed circuit board is polyester or polyamide.
3. A sensor assembly according to claim 1 or 2, in which the substrate includes an adhesive layer.
4. A sensor assembly according to any one of claims 1, 2 or 3, in which the sensor includes an antenna cluster comprises a radar transmit antenna and two receive antennas, the transmit antenna mounted between the receive antennas, a first receive antenna facing towards the front of the vehicle and a second receive antenna facing towards the rear of the vehicle.
5. A sensor assembly according to any one of the preceding claims, in which the electronics are mounted near the centre of the flexible printed circuit board.
6. A sensor assembly according to any one of the preceding claims, in which each sensor is a radar sensor.
7. A sensor assembly according to claim 6, in which each sensor is an impulse radar sensor.
8. A sensor assembly arranged substantially as described herein with reference to and as illustrated in figures 1 and 2 of the accompanying drawings.



# The Patent Office

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Application No: GB 9718364.4  
Claims searched: 1-8

Examiner: Steven Davies  
Date of search: 22 January 1998

## Patents Act 1977 Search Report under Section 17

### Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.P): G1N-NAGCR, NAGDR ; H4D-DRPC, DSH

Int CI (Ed.6): G01S-7/03, 13/93 ; H05K-1/00

Other: Online database: WPI

### Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2287917 A (ROBERT BOSCH)	
A	EP 0144837 A2 (SOLITRON DEVICES)	

X Document indicating lack of novelty or inventive step  
Y Document indicating lack of inventive step if combined with one or more other documents of same category.

& Member of the same patent family

A Document indicating technological background and/or state of the art.  
P Document published on or after the declared priority date but before the filing date of this invention.  
E Patent document published on or after, but with priority date earlier than, the filing date of this application.